

Development of a Naturalist Course for Manta Tour Guides in Hawaii

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Abstract: The Kona Coast on the island of Hawaii is a world-class destination for those who seek marine wildlife interactions. One activity that sets Kona apart from other worldwide tourist destinations is the opportunity to observe manta rays in the wild. Manta tour guides act as authorities about manta rays while conducting tours, however, there was no official course for these guides. To fill this need, the *Manta Naturalist Course for Manta Tour Guides and Operators* was developed and delivered. The purpose of this instructional design project was to develop and evaluate the first module in this naturalist course for manta tour guides offered through Hawaii Community College, Office of Continuing Education and Training in Kona, Hawaii. The course includes two face-to-face classroom sessions along with an online component. The learning management system is through the University of Hawaii at <https://laulima.hawaii.edu/portal> and the content for the course can be found at <http://www.mantanaturalist.com>. The Dick and Carey Model offered the framework for instructional design and Keller's ARCS Model (Attention, Relevance, Confidence, Satisfaction) was employed throughout the development. Using Web 2.0 tools, the course content was developed from a curated collection that included original underwater videos as well as meaningful online resources. Special emphasis was placed on visual design elements for course materials and web site. Design choices based on theory were compared with practical application. Based on feedback, modifications were made. Lessons learned and recommendations for future courses are highlighted.

Introduction

The Kona coast on the island of Hawaii is a world-class destination for ocean recreation. Whether boat cruises, snorkeling excursions, or scuba diving tours, people come to Kona to experience the beauty and awe of Hawaii's underwater world. One activity that sets Kona apart from other worldwide tourist destinations is the opportunity to observe one of the largest animals in the ocean – the majestic manta ray.

Manta excursions originated in Kona in the 1980's when scuba diving operators would take certified divers on underwater tours at night to view the mantas. The original manta dive site is located near Keauhou Bay on the Kona coast of Hawaii where a large hotel

would shine bright lights into the water at night to offer an illuminated ocean vista for their guests. The light in the water attracted plankton and the plankton attracted manta rays. Dive operators started taking divers to this site at night by boat. Divers with underwater lights descended to the ocean floor 30 feet below. With wingspans up to 12 feet across, manta rays would glide, pivot, or somersault above divers - a thrilling experience for those who sought adventure.

Popularity in this tour grew rapidly. For over two decades, the Kona Manta Ray Night Dive was primarily an activity for scuba divers. However, in a five-year span from 2007 to 2012, big changes occurred in the manta tour industry. The overall numbers of boats, divers, snorkelers, and mantas increased across the board, however, the most significant change was the increase in the number of snorkelers (See Figure 1).

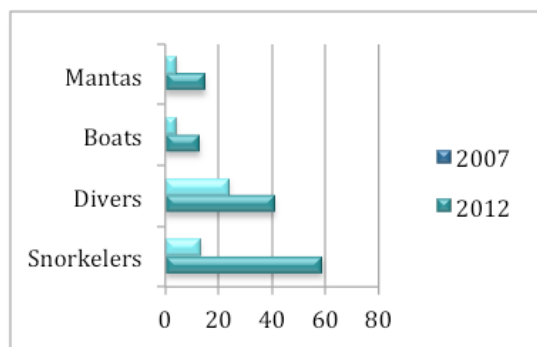


Figure 1: Average number of mantas, boats, divers, and snorkelers per night during the months of June, July, and August for 2007 and 2012. Retrieved from Manta Pacific Research Foundation Nightly Manta Reports.

Changes in modes of operation as well as the increase in numbers created contention among operators at the manta site. In the fall of 2012, the United States Coast Guard and officials from the Department of Land and Natural Resources of the State of Hawaii mandated operators to create standards of best practices for the safety of the mantas, their environment, and the people on the manta night tour. Manta Pacific Research Foundation led a working group of operators to produce a more comprehensive code of conduct with the goal to educate those people involved. Through this process, the idea for *Manta Naturalist course for Manta Tour Guides and Operators* was born.

By 2014, over 30 manta tour operators conducted manta trips throughout the year. On one night in the summer of 2014, the Makako Bay manta site had reports of 45 mantas, 22 boats, and 250 people – big numbers for one site. Annually, up to 50,000 people participate in manta tours and approximately 200 guides are employed in the industry (Manta Pacific Research Foundation, unpublished).

Manta tour guides act as authorities offering interpretive education while conducting nightly tours, however, there was no official course or certification for these guides. To fill this need, the *Manta Naturalist Course for Manta Tour Guides and Operators* was

developed and implemented in February of 2015. The goals of the Manta Naturalist course are to expand the students' basic knowledge of manta rays, create awareness of manta ray research and conservation, and to familiarize students with the Manta Tour Operator Standards. Students create and practice a manta naturalist briefing during the course that can be transferred to the work place when conducting manta tours. The hope is that by sharing accurate and interesting information, the experience of their guests is enhanced and the industry standards are followed. The course consists of two face-to-face class sessions and online instruction.

The Manta Naturalist course is divided into three modules that correspond to the course goals. Module One covers manta ray information including a basic description, scientific classification, anatomy, life cycle and behaviors. The purpose of this instructional design project was to develop and evaluate the first module in a naturalist course for manta tour guides offered through a community college in Kona, Hawaii.

Literature Review

For the past three decades, a new type of nature-based tourism emerged that highlights marine wildlife interactions. It started with cetacean based tours such as whale watches (Forestell, 1993), but evolved worldwide to in-water experiences with a variety of marine animals such as manatees, dolphins, sea turtles, and whale sharks. Interpretive education programs have been implemented in places such as Florida, USA with manatees (Shackley, 1992), Tangalooma, Australia with wild bottlenose dolphins (Orams, 1997), New Zealand with wild dusky dolphins (Luck, 2003), Queensland, Australia with sea turtles (Ballantyne, Packer, & Hughes, 2008), and whale sharks at Isla Holbox, Mexico (Ziegler, Dearden, & Rollins, 2011). Manta tours in Kona, Hawaii fall into the category marine wildlife tourism, yet an interpretive education program for guides had not been established until now with the Manta Naturalist Course.

Zeppel (2008) states, "Marine wildlife interpretive programs that highlight species biology and human impacts influence visitor attitudes, beliefs, and conservation outcomes." The Manta Naturalist Course was created to educate interpretive guides and begins the course with species biology.

In the first lesson of Module One, a basic description including size, shape, and color is presented (Randall, 2007). Using a recommendation from Dick, Carey, and Carey (2009), examples and non-examples are included (p. 175). For example, manta rays are related to sharks, both have cartilaginous skeletons, however, many shark species have large, sharp teeth whereas manta rays do not. They do have a sandpaper-like tooth band on the lower jaw only (Marshall, Simon, & Bennett, 2008). A second example outlines how sharks are related to stingrays since both have flattened body shapes and pectoral fins fused to their heads. Yet, stingrays have tail stingers and manta rays do not (Crow & Crites, 2002). A description of both species of manta ray, *Manta birostris* and *Manta alfredi*, (Marshall, Compagno, & Bennett, 2009) along with an explanation of color morphology (Ari, 2014) is also included in first lesson.

In the second lesson, manta anatomy is described with an emphasis on the specialized head fins called cephalic fins (Ari, 2011). Other notable anatomical features include the cloaca, a slit on the underside of the animal that leads to a cavity where intestinal, urinary, and reproductive canals (female) open. Claspers, the male sex organs located along the inside edge of the pelvic fins, are also described (Michael, 1993).

The third and last lesson in Module One of the Manta Naturalist Course includes information about manta life cycle and manta behaviors. For example, manta rays are fish and most fish lay eggs, however, manta rays give birth to live young. According to researchers, the manta ray embryo is not attached to the mother through an umbilical cord like other animals that give live birth. Instead, manta rays obtain oxygen by buccal-pumping the uterine fluid in the same way embryos of egg-laying species do (Tomita, Toda, Ueda, Uchida, & Nakaya, 2012).

Framework for Instructional Design

The framework used for this instructional design project was based on the Dick and Carey Model of developing an instructional strategy. This strategy is organized into five major learning components that include pre-instructional activities, content presentation, learner participation, assessment, and follow-through activities. These five components can be applied to each domain of learning (Dick et al., 2009). The Manta Naturalist Course starts with the domain of verbal information to create a foundation of accurate manta knowledge that will later be applied in the course when students prepare and perform their manta naturalist briefing.

1) Pre-instructional activities

According to Dick et al. (2009), pre-instructional activities include gaining attention and motivating the learners, describing objectives, and describing and promoting recall of prerequisite skills. Dick and Carey's strategy was influenced by Gagne's theory of instruction and Keller's ARCS model. "Gaining attention – a stimulus change to alert the learner and focus attention on desired features" is the first item in Gagne's list of nine events of instructional activities (Reiser & Dempsey, 2012, p. 40). Gaining attention is the 'A' in Keller's ARCS model (Keller, 2000). When developing the Manta Naturalist Course, a beautiful image of a manta ray is located on the home page of the course web site to initially gain attention (Appendix A).

According to Dick et al. (2009), one of the best ways to motivate learners is to use human-interest examples. In a pre-instructional activity in the Manta Naturalist Course, students are asked to introduce themselves by sharing one of their best manta encounters or favorite manta story. With this activity, students started the course by connecting their previous experiences to instruction. This created relevance, the R in Keller's ARCS model.

Pre-instructional activities should also describe the objectives for the lesson. This relates to confidence or the 'C' in the ARCS model. Keller (2000) states, "By making objectives

clear and providing examples of acceptable achievements, it is easier to build confidence” (p. 2). The objectives of each lesson in Module One are located on the top, left side of the course web page opposite a beautiful image of a manta ray. They are presented in an easy-to-read bullet point format.

Developing objectives is an extremely important exercise in instructional design. Hodell (2011) states, “Objectives should be measurable and observable” (p. 91). When creating measurable objectives, instructional designers often refer to Bloom’s taxonomy. Bloom’s list of action verbs can be categorized into the following: remembering, understanding, applying, analyzing, evaluating, and creating (Dunn, 2014). Module One in the Manta Naturalist Course employs the action verbs in the first category (remembering) with words such as define, describe, identify, list, name, recall, and state.

According to Dick et al. (2009), pre-instructional activities should describe and promote prerequisite skills. The students in the Manta Naturalist Course are asked to take a pre-test to introduce them to the material and to recall their prerequisite knowledge.

2) Content Presentation

The content for the Manta Naturalist Course is presented in a web site. The online content is formatted to create learning guidance and is basically the ‘textbook’ for the course. As Dick et al. (2009) state, “A textbook contains the simplest example of learning guidance in the way text is laid out with section headings, subheading, and paragraph headings, bulleted lists, and so forth. This embedded outline is our cue to the structure of the content and makes it easier to learn and remember” (p. 175). The Manta Naturalist Course web site follows a similar structure of a classic textbook with headings, subheadings, and bulleted lists. However, instead of flipping through paper pages, students can move through the material by scrolling down, clicking on links in the menu bar or using embedded links on each web page.

The visual design of the web site is purposely formatted for learning guidance while helping to maintain motivation through visual appeal. Similar sections have consistent layout and color schemes to provide cues and guidance to the learner. Each web page is divided into thirds. Golombisky and Hagen (2013) state, “Like the golden proportion, the rule of thirds is merely a 3 x 3 grid that suggests layout placement in order to create visually interesting asymmetrical designs” (p. 53).

3) Learner Participation

The next learning component in the Dick and Carey Model is learning participation. Practice activities with feedback help the learner process the information and build confidence (Dick et al., 2009). The content delivered online in the Manta Naturalist website includes text, images, and video. Students can actively participate by navigating the site and clicking on videos. The content and videos can be reviewed easily. In addition, a practice test with immediate feedback is available for Module One in the learning management site. During face-to-face sessions, the instructor presented slide

presentations that corresponded to each module. At the end of Module One, the instructor reviewed a series of practice questions that were similar to the practice test online. Immediate feedback was given on corresponding slides and discussion was prompted when the students needed further explanation.

4) Assessment

Assessment is next in the Dick and Carey Model. According to Simonson, Smaldino, Albright, and Zvacek (2012),

“ . . . a good assessment tool matches the objectives; learners know what to expect because they have already been made aware of what is important and how they will be expected to demonstrate their mastery of this knowledge or skill. This characteristic is often referred to as alignment, indicating an acceptable degree of synchronicity among objectives, instructional activities, and assessment measures” (p. 267).

For this study, the assessments include a pretest, practice test, and posttest. The objectives and test questions of the Manta Naturalist Course are aligned.

5) Follow-through Activities

The last component in the Dick and Carey framework is follow-through activities for the student. This includes memory aids and transfer considerations (Dick et al., 2009). For the final project, students prepared and delivered a manta naturalist briefing with an emphasis on providing accurate manta information from Module One. Manta Pacific Research Foundation provided five 11 x 17 inch laminated sheets for each student to use as a memory or job aid when giving the presentation in class and later in the field. The goal in this activity was to provide practice and a memory aid to promote confidence while the student achieved satisfaction in the learning experience. In Keller’s ARCS model, the ‘S’ is for satisfaction.

Project Development

The first tool used in developing this project was a cloud-based web development platform called Wix (Appendix A). The Manta Naturalist Course can be found online at www.mantanaturalist.com. Although the site may change over time, this is the current online address. The web site includes the following: a home page, directions (Appendix B), a syllabus (Appendix C), a schedule (Appendix D), modules (Appendix E), lessons (Appendix F), still images, and original videos (Appendix G).

Developing a web site for the course provided multiple benefits. The Wix template allowed customization with colors, fonts, formatting, and images. As mentioned, the web site acts more like a ‘textbook’ for the course, however, the advantages of visual appeal, imagery, and embedded video are vast improvements over a traditional printed textbook. Course content was added from a curated collection that included original underwater

videos as well as meaningful online resources. For example, original underwater manta ray videos were uploaded to a YouTube Channel and the YouTube link was embedded into the Wix site (Appendix H). In addition, supplementary information could be easily added with links to other online resources. For example, in the anatomy lesson a link to a web page about the latest manta brain research was included. In the life cycle lesson, a direct link to an open access research paper about manta reproduction was added (Appendix I).

The biggest drawback to the Wix site was the inability to create practice exercises or assessments. At first, ‘Quick Review’ web pages were developed after each lesson that included a series of true or false practice questions that aligned to the objectives and posttest questions. The student could then click on a link to an answer page. However, this method proved ineffective and cumbersome, so it was removed before implementation of the course.

In an attempt to find a tool to accommodate content and assessments, Adobe Captivate was tried. With features such as interactive eLearning experiences, assessments, and scoring, it seemed like a viable alternative. However, four obstacles arose once this tool was employed. First, the learning curve in mastering this tool was too steep in the time that was allowed for project development. Second, the overall look was not as visually appealing as the Wix site (Appendix J). Third, in order to create interactivity and assessments, page development would number in the several hundreds, especially if developing for responsive technology (pages for computer, tablet, or mobile phone). Fourth, after the 30-day trial, the product came with a price. In hindsight, exploring this product in an attempt to solve the problem of interactivity and assessments was a distraction that hindered progress in project development, especially in terms of achieving tasks in the timeline.

Another unexpected problem with the Wix web site was web browser incapability. The web site was created on wix.com while using Safari as a browser. Later when showing the site to others on a different computer using Firefox as the browser, links and embedded videos were situated differently from the original format, such as on top of text (Appendix K). It was very distracting visually and not professional. The solution to this problem is still being worked on. Students are advised to use Safari or Chrome as browsers when accessing the web site.

To fill the need for interactivity and assessments, a second online tool was employed. It’s called Laulima, the learning management system used by the University of Hawaii. In order to use Laulima, the Manta Naturalist Course was administered through the University of Hawaii, Hawaii Community College (HCC), Office of Continuing Education and Training (OCET). First, Laulima provided student interactivity with a discussion board. Students were asked to introduce themselves and to respond to at least two other classmates. Participation was graded. This proved to be very effective and helped to build a sense of community in the experience. Second, Laulima provided a venue for practice exercises. Students could take a practice quiz for Module One as many times as they wanted. Immediate feedback was provided. Third, the course assessments

were delivered through Lulima that included a 15 question graded test on Modules One, Two, and Three (Appendix L). Next, Lulima provided a grade book where students could see their results from the pretest, practice test, posttests, activity, and final project. Lastly, the Wix web site was actually viewable through Lulima and this was advantageous for keeping the site more private and password protected, however, the direct URL for the Manta Naturalist Course web site was provided to students for convenience.

Four problems occurred with Lulima, the University of Hawaii learning management system. The first problem was the steep learning curve when building the course site. Usability was not intuitive and it took time and help from others to learn how to use this tool. The second problem was the tremendous amount of time it took to populate the site with content, especially test questions. Emerging instructional designers may want to critique the assessment tool they employ based on the ease of transferring detailed information such as test questions and answer selections. It was painstaking to populate content into this tool. Third, Lulima has minimal visual design qualities and looks quite outdated. Fourth, Lulima was available due to the relationship through Hawaii Community College (HCC). Working with HCC was difficult especially in terms of logistics, permissions, and paperwork. This added a whole new level of obstacles and time demands that were not considered during the planning phase.

Several other tools were required in the development of this course. The primary computer used was a MacBook Pro using Mac OSX version 10.7.5 operating system. Original underwater video footage was edited using iMovie by Apple, Inc. The movies were then converted to an Apple Quicktime format before being uploaded to a newly created YouTube channel for this project. Original artwork, course flyers, and the job aid were created using Adobe Illustrator (Appendix M) and then converted using Adobe Acrobat to a portable document file (PDF). Images used in the course flyer, web site, slide presentations, job aid, and other student materials were manipulated using Adobe Photoshop to enhance color, crop, or reduce. The slide presentation in the face-to-face course was developed in Microsoft PowerPoint (Appendix N). Microsoft Word was used for various documents and printed materials. Online, surveys and the pretest were created in Google Drive using Google Forms and a link was shared to students by e-mail.

Conclusion

The Manta Naturalist Course instructional design project was the final project in a three-year journey in the Learning Design and Technology masters program at University of Hawaii, Manoa. By using the Dick and Carey model as the framework for the course, the design process flowed nicely. Dick et al. (2009) state, "The purpose for the model is to help you learn, understand, analyze, and improve your practice of the discipline." They give the advice to "trust the model" (p. 4). The model worked well in this project.

With a solid foundation in instructional design theory, modern technological tools were employed to deliver the course. Web 2.0 tools such as a cloud based web site builder proved to be easy to use with more control over visual design and layout. However,

needed features in online instruction such as interactivity and assessments were lacking. In an attempt to find one online tool with all the features, problems arose with the project timeline. Finding the right tools early in the project is best. It's also important to be mindful of the multitude of instructional details such as directions, syllabus, schedules, objectives, content, activities, and assessments and how this relates to populating a web site or learning management system. Transferring information is very time consuming. In addition, modifications based on feedback require diligent attention. The time commitment to make improvements must be budgeted for in a large project such as this.

When the *Manta Naturalist Course for Manta Tour Guides and Operators* instructional design project was implemented, it was very exciting to see the project come together as planned. The course was well received and Hawaii Community College has agreed to schedule more courses. Future courses will be implemented using the same design and format – a true testament to the quality of the original project.

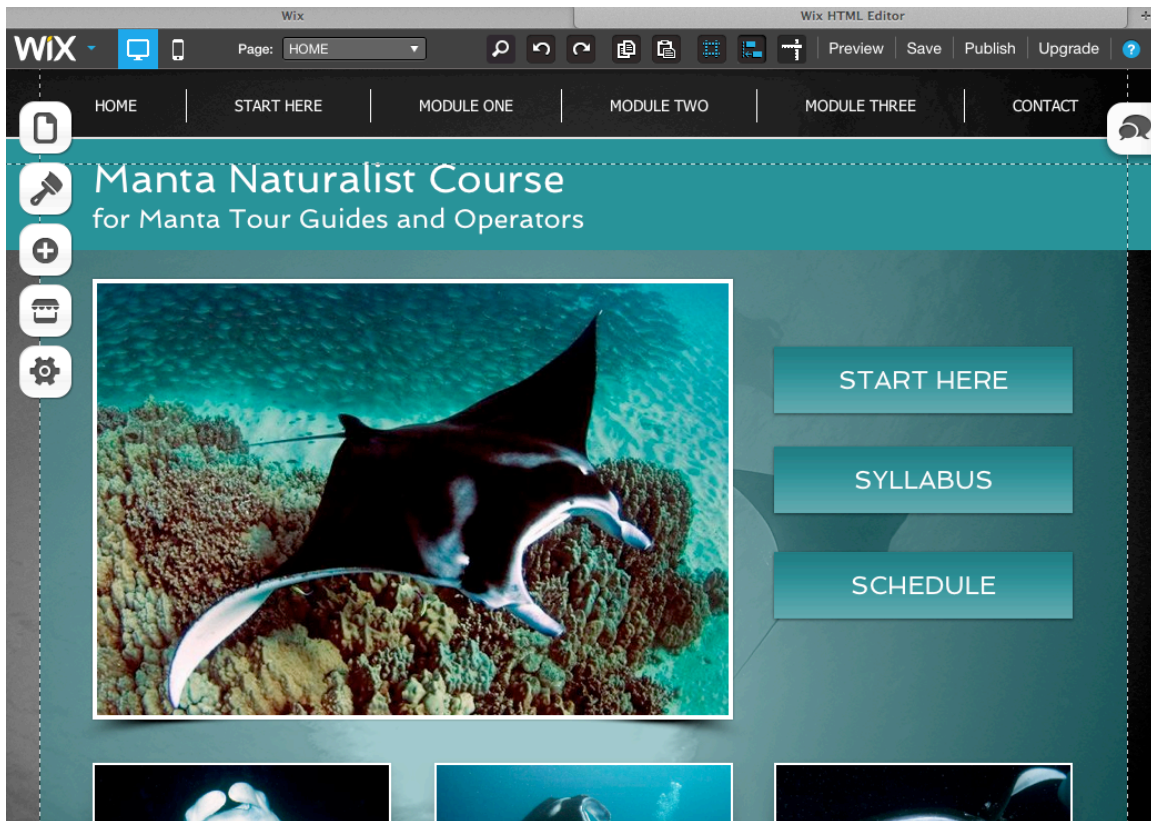
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APPENDIX A

Building the web site on Wix.



APPENDIX B

Direction page on the Manta Naturalist web site.

[HOME](#) | [START HERE](#) | [MODULE ONE](#) | [MODULE TWO](#) | [MODULE THREE](#) | [CONTACT](#)

Manta Naturalist Course START HERE

Welcome to the Manta Naturalist Course!

STEP ONE: CHECK OUT THE WEB SITE
Take some time to scan the web site. Watch some of the videos, click on some of the links. Just have some fun!

STEP TWO: SYLLABUS & SCHEDULE
Please review the syllabus and schedule on this web site for more information about the course.

STEP THREE: INTRODUCTIONS
Your first task will be to introduce yourself. You will do this in class, but also make a post in Laulima, the University of Hawaii (UH) learning management system.

Using Laulima will be introduced in the first class session. An email will be sent to you after the first class with directions about your user name and password for the site. In the meantime, please think about answers to these questions for your introduction:



[SYLLABUS](#)

[SCHEDULE](#)

[LAULIMA](#)

[MODULE ONE](#)

APPENDIX C

Syllabus page on the Manta Naturalist web site.

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Manta Naturalist Course SYLLABUS

COURSE DESCRIPTION AND GOAL
 This course is designed for manta tour guides and operators in the marine tourism industry on the Kona Coast of the island of Hawaii. The course will include online learning and two face-to-face sessions. The goals of the Manta Naturalist course are to expand the students' basic knowledge of manta rays, create awareness of manta ray research and conservation, and to familiarize students with the Manta Tour Operator Standards. Students will create and practice an interpretive educational briefing about manta rays and will ultimately use this naturalist presentation with their guests to educate those who enjoy the experience.

COURSE LAYOUT
Class Session One:

- Day and Date: Tuesday, February 17, 2015
- Time: 9 a.m. to 12 noon
- Location: Jack's Diving Locker in the Coconut Grove Marketplace, Kailua-Kona, Hawaii.
- Includes: Welcome orientation by instructor and presentations by guest speaker.

Class Session Two:

- Day and Date: Tuesday, February 24, 2015
- Time: 9 a.m. to 12 noon
- Location: Jack's Diving Locker in the Coconut Grove Marketplace, Kailua-Kona, Hawaii.





[SYLLABUS](#)
[SCHEDULE](#)
[LAULIMA](#)
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APPENDIX D

Schedule page on the Manta Naturalist web site.

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Manta Naturalist Course SCHEDULE

By Sunday, February 15th:


- After registering for course, a Welcome Email will be sent with a link to a course pre-test (15 points awarded for participation). Please complete by Sunday, February 15th at 11:55 a.m.

Tuesday, February 17th - 9 a.m. to 12 noon

- Class Session One
- Location: Jack's Diving Locker in the Coconut Grove Marketplace.
- Includes: Introduction by instructor, guest speaker presentations, and directions for online learning and final project.

During Week between February 17th - 24th

- By Wednesday, February 18th at 11:55 p.m., complete introduction post (5 points) in Laulima, the University of Hawaii learning management system.
- By Friday, February 20th at 11:55 p.m., post response



SCHEDULE

SYLLABUS

LAULIMA

MODULE ONE

APPENDIX E


Landing page for Module One

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Manta Naturalist Course

MODULE ONE: All About Mantas


LESSON 1



Lesson 1:
General Description and Scientific Classification

- General Description
- Sharks and Rays
- Stingray versus Manta Ray
- Devil Rays
- Manta Species
- Manta Coloration


LESSON 2



Lesson 2:
Manta Ray Anatomy

- Cephalic fins
- Mouth
- Tooth Band
- Branchial Filters
- Gills
- Head
- Eye
- Spiracles

LESSON 3



Lesson 3:
Life Cycle & Behavior

- Gender
- Courtship
- Mating
- Reproduction
- Manta cleaning stations
- Manta feeding behavior

APPENDIX F

Example of a lesson page on the Manta Naturalist web site.


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MODULE ONE: All About Mantas

LESSON 1: General Description and Scientific Classification

By the end of this lesson, you should be able to:

- Give a general description of a manta ray that includes:
 - Distribution
 - Size and shape
 - Origin of name
- Name the scientific term for cartilaginous fishes.
- State one important difference between stingrays and manta rays.
- Identify the common characteristic of devil rays.
- Name the two species of manta rays.
- Describe variations in manta coloration.




General Description

Manta rays are large sea animals that live in tropical, sub-tropical, and temperate waters worldwide. Their side or pectoral fins have evolved into wide triangular wings that they use to easily propel themselves through the

APPENDIX G

Example of embedded original videos on Manta Naturalist web site.

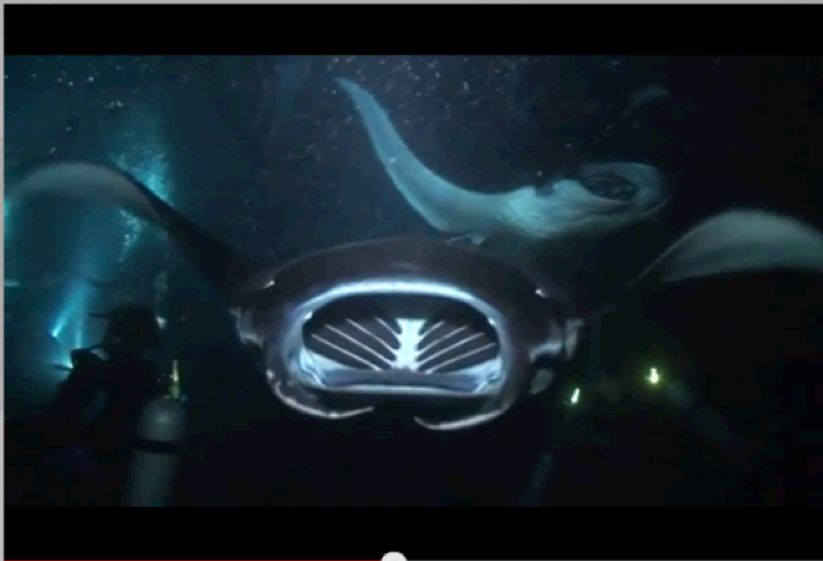
Manta Naturalist



0:04 / 0:09

Mouth

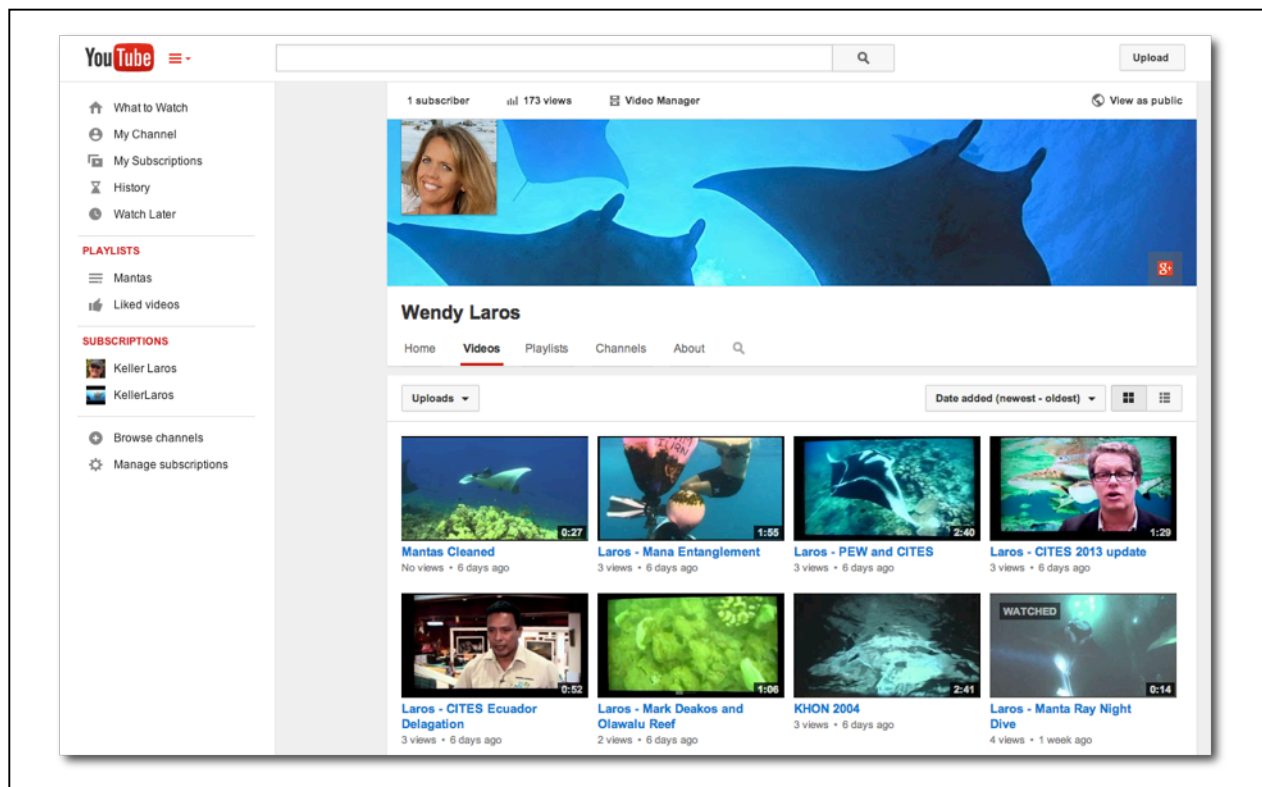
The mouth of the manta ray is located on the front edge or anterior side of the animal. It's a very wide mouth and leads to a large cavernous area inside the manta when opened.



0:07 / 0:46

APPENDIX H

Curated collection of videos on new YouTube Channel



APPENDIX I

Manta Naturalist web site provides online links to resources



Reproduction

In regards to reproduction, most fish produce eggs. Manta rays are fish, however, they give birth to live young. Some cartilaginous fish like manta rays are ovoviviparous. The meaning of this word is as follows: ovum (egg), vivius (alive), and papere (to produce). In other words, manta rays produce live young hatched from an egg. Manta rays hatch in the female's oviduct from a thin membranous egg case and remain inside of the mother until they are fully developed. According to researchers, the manta ray embryo is not attached to the mother through an umbilical cord like other animals that give live birth. Instead, manta rays obtain oxygen by buccal-pumping the uterine fluid in the same way embryos of egg-laying species do. The uterine fluid is also thought to supply nutrients.

RESEARCH PAPER

Green box (above) with words 'RESEARCH PAPER' is a link to the original study (below) that can be accessed directly online.

Manta Naturalist
rsbl.royalsocietypublishing.org/content/roybiolett/early/...

Downloaded from <http://rsbl.royalsocietypublishing.org/> on April 18, 2015

biology
letters

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Animal behaviour

Live-bearing manta ray: how the embryo acquires oxygen without placenta and umbilical cord

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We conducted an ultrasonographic experiment on a pregnant manta ray, *Manta alfredi* (Chondrichthyes, Batoidae). This study showed how the embryo of the live-bearing elasmobranchs respire in the body of the female. In the embryonic stage, the manta ray embryo takes in uterine fluid by buccal-pumping. After birth, the manta ray shifts its respiratory mode from buccal-pumping to ram-ventilation. The rapid reduction of the spiracle size in the young manta ray may reflect this shift of respiratory mode.

Unlike mammals or some carcharhinid sharks that acquire oxygen through a placenta and umbilical cord, the manta ray embryo does not have a direct connection with the mother. Thus, the manta ray embryo obtains oxygen by buccal-pumping of the uterine fluid, in the same way that the embryos of egg-laying species obtain oxygen from the water in the egg case. This finding extends our understanding of the diversity of embryonic respiratory systems in live-bearing vertebrates.

Keywords: buccal-pumping; echosonography; embryo; live-bearing; manta ray; respiration

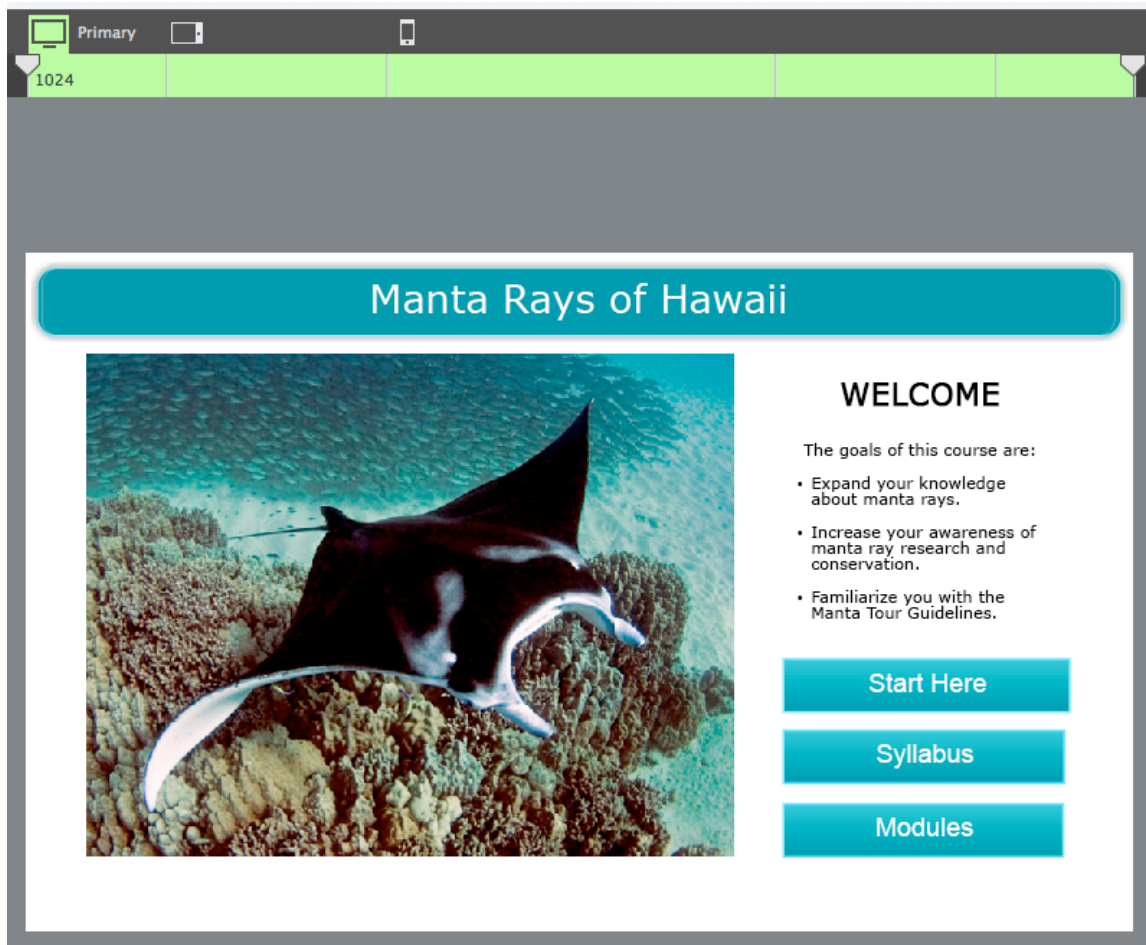
of the manta ray may yield an understanding of the mystery of how the embryos of most viviparous elasmobranchs (sharks and rays) respire in the body of the female without a placenta or umbilical cord. Embryonic respiration of the viviparous elasmobranchs has been studied using the ultrastructure of the uterus [3–5], but the respiratory system of the embryo itself is still poorly understood.

In June 2009, a female manta ray was born at Okinawa Churaumi Aquarium in Japan. This event provided us the first opportunity to access the embryonic respiratory behaviour of viviparous elasmobranchs. Myliobatiform stingrays, including the manta ray, have a unique viviparous reproductive mode, which is called a 'lipid histotroph' [6,7]. In this reproductive mode, a placenta is not formed, but the embryo is grown to large sizes in the uterus mostly by the lipid-rich 'milk' secreted from the uterine wall [1,3,4,6,7]. However, it is not understood how this milk, as well as oxygen, is taken in by embryos, in the absence of an umbilical cord.

The purposes of the present paper are (i) to describe the kinematic and morphological characteristics associated with the respiratory system of the viviparous manta ray embryo and (ii) to compare the embryonic respiratory system of the manta ray with those of other viviparous and oviparous elasmobranchs.

APPENDIX J

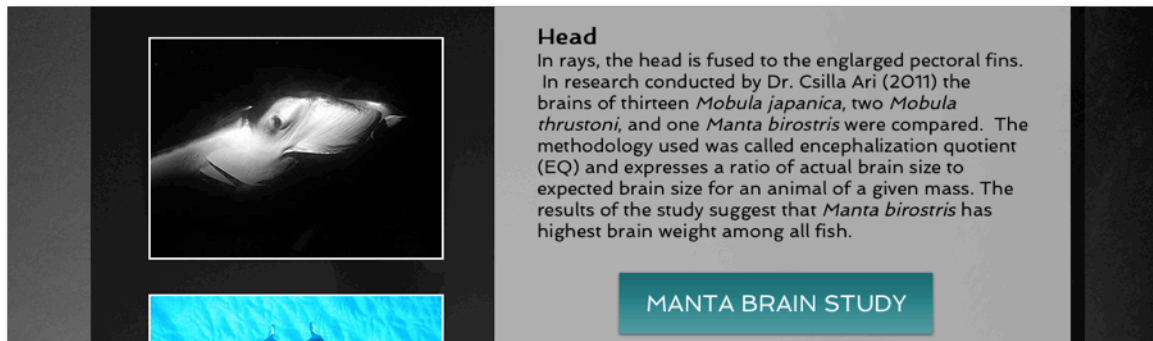
Adobe Captivate – exploring an alternative online delivery method



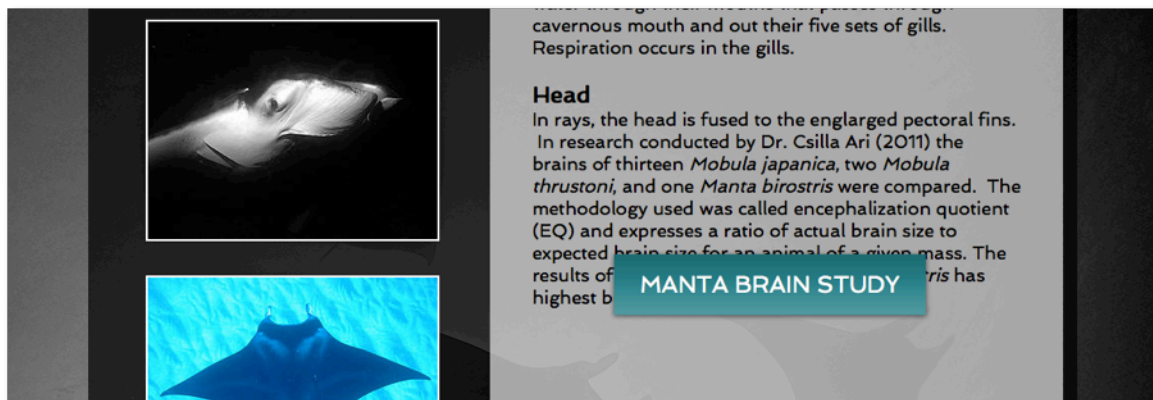
This tool was not used.

APPENDIX K

Manta Naturalist web site – different format with different browsers



Browser: Safari, the correct format.



Browser: Firefox, problem with format.

APPENDIX L

Laulima – University of Hawaii learning management system

The screenshot displays the Laulima learning management system interface. On the left is a navigation sidebar for Hawaii Community College, featuring links to Home, Announcements, Manta Course, Discussion and Private Messages, Tests & Quizzes (highlighted), Gradebook, Site Info, and Help. The main content area is titled "ETEC-632 Manta Naturalist: Tests & Quizzes". Below this, a message box states "Assessment Preview - This is an example student view of this assessment" with a "done" button. The section "Quiz - Module 1" includes a "Table of Contents" button. The quiz itself is "Part 1 of 1 - Module One Quiz". The current question is "Question 3 of 15", asking which attribute is NOT shared by manta rays and stingrays. The options are: A. Cartilaginous skeleton, B. Flattened body shape, C. Tail stingers or barbs, and D. Wide pectoral fins fused to head. A "Reset Selection" link is provided. At the bottom, there are checkboxes for "Mark for Review" and "What's This?", and navigation buttons for "Previous", "Next", "Save", and "Exit".

Hawaii Community College

Home

Announcements

Manta Course

Discussion and Private Messages

Tests & Quizzes

Gradebook

Site Info

Help

ETEC-632 Manta Naturalist: Tests & Quizzes

1 Assessment Preview - This is an example student view of this assessment [done](#)

Quiz - Module 1

[Table of Contents](#)

Part 1 of 1 - Module One Quiz

Question 3 of 15

Manta rays are related to stingrays. These animals share the all of the following attributes EXCEPT one. Please choose that one.

- ☐ A. Cartilaginous skeleton
- ☐ B. Flattened body shape
- ☐ C. Tail stingers or barbs
- ☐ D. Wide pectoral fins fused to head

[Reset Selection](#)

☐ Mark for Review [What's This?](#)

[Previous](#) [Next](#) [Save](#) [Exit](#)

APPENDIX M

Adobe Illustrator - original artwork and course materials

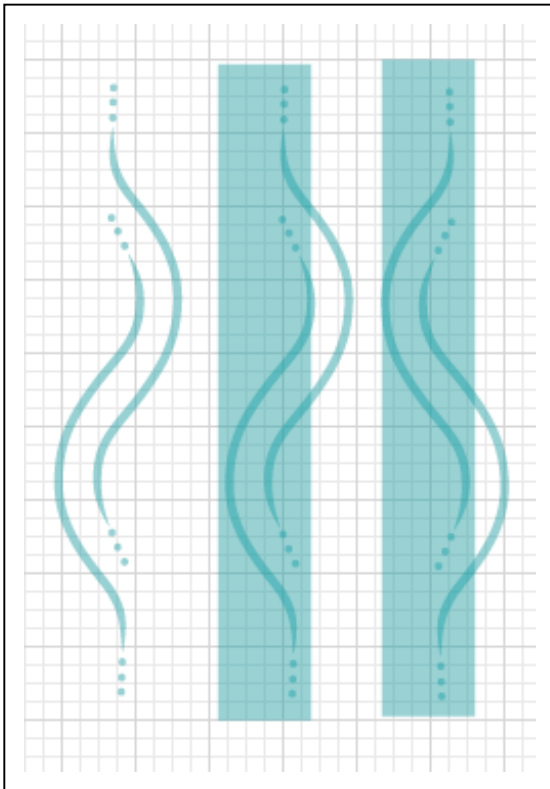


Photo by Go Padua



Manta Naturalist Course

for Manta Tour Guides and Operators

Tuition: \$95

Two Class Sessions:
February 17 & 24, 2015
Tuesdays 9 a.m. to 12 noon

Location:
Jack's Diving Locker
Coconut Grove Marketplace

Online:
Three Modules - 6 hours

Registration:
Hawaii Community College -
Office of Continuing
Education and Training
(808) 934-2700
ocephawc@hawaii.edu
Course Code: HOSP1001

Instructor: Wendy Laros
laros@hawaii.edu

This course is designed for manta tour guides and operators in the marine tourism industry on the Kona Coast of the island of Hawaii. The course will include online learning and two face-to-face class sessions.

The goals of the Manta Naturalist course are to expand the student's basic knowledge of manta rays, create awareness about manta ray research and conservation, and to familiarize students with the Manta Tour Operator Standards.

Students will develop and deliver an interpretive educational briefing about manta rays. Ultimately, students will use this naturalist presentation with their guests to educate those who enjoy the experience.

Guest Speaker: Keller Laros
Manta Pacific Research Foundation

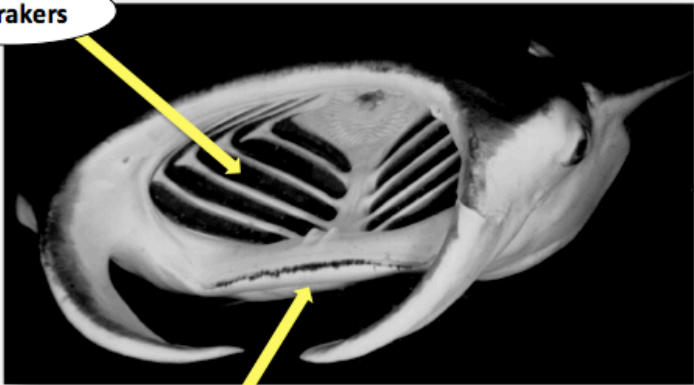




Appendix N
Microsoft PowerPoint for slide presentations

Module One: All About Mantas

Manta mouth and feeding



The diagram shows a manta ray's head in profile, focusing on the mouth area. Two yellow arrows point from labels to specific parts of the mouth. One arrow points to the gill rakers, which are a series of parallel, comb-like structures. The other arrow points to the tooth band, which is a rough, sandpaper-like strip along the lower jaw.

Gill rakers

Tooth band

- Mantas capture plankton with gill rakers, also called branchial filters.
- Manta rays possess a sandpaper-like tooth band along the lower jaw only.